

CLAIMS

1. A legged mobile robot having at least a plurality of movable legs, comprising:

a relative movement measurement sensor arranged on the foot sole of each movable leg for measuring the amounts of relative movements between the foot part and the road surface; and

a controller for controlling the movements of the legged mobile robot based on the amounts of relative movements between the foot part and the road surface as measured by the relative movement measurement sensor.

2. The legged mobile robot according to claim 1 wherein the relative movement measurement sensor measures the amount of the relative movement of the foot part relative to a direction parallel to the road surface and/or the amount of the relative movement of the foot part around a normal of the road surface.

3. The legged mobile robot according to claim 1 wherein the relative movement measurement sensor includes a rotationally mounted ball having its surface partially exposed to outside the foot sole, a first rotation unit for detecting the rotation in a first direction of the ball, a second rotation unit for detecting the rotation in a second direction of the ball and a calculation unit for calculating the amount of the relative movement of the foot part relative to the road surface in the first and second directions.

4. The legged mobile robot according to claim 1 wherein the relative movement measurement sensor includes imaging means for imaging a ground touching surface of the foot part, image processing means for comparing images photographed by the

imaging means at a preset time interval and calculating means for calculating the amount of the relative movement relative to the road surface of the foot part at the preset time interval based on the results of image comparison by the image processing means.

5. The legged mobile robot according to claim 1 wherein the relative movement measurement sensor is able to measure the amount of the relative movement of the foot part in a direction parallel to the road surface and calculates the amount of the relative movement around a normal of the road surface by chronologically joining the amounts of the relative movement in the direction parallel to the road surface of the foot part as measured at preset time intervals.

6. The legged mobile robot according to claim 1 wherein two or more relative movement measurement sensors are provided on each foot part at a spacing from one another and wherein the measured results of the relative movement measurement sensors are compared to one another to calculate the amount of the relative movement of the foot part around a normal of the road surface.

7. The legged mobile robot according to claim 1 wherein said controller halts the movement on the road surface responsive to the amount of the relative movement between the foot part and the road surface exceeding a preset threshold value during movement on the road surface.

8. The legged mobile robot according to claim 1 wherein said controller halts the movement on the road surface responsive to the amount of the relative movement

between the foot part and the road surface exceeding a preset threshold value during movement on the road surface and verifies whether or not the movement operation can further be continued.

9. The legged mobile robot according to claim 1 wherein said controller halts the movement on the road surface responsive to the amount of the relative movement

between the foot part and the road surface exceeding a preset threshold value during

movement on the road surface, verifies whether or not the movement operation can

further be continued and executes a preset assistance request operation in case the

controller verifies that the movement operations cannot be continued

10. The legged mobile robot according to claim 1 wherein said controller halts the

movement on the road surface responsive to the amount of the relative movement

between the foot part and the road surface exceeding a preset threshold value during

movement on the road surface and searches the state of the road surface.

11. The legged mobile robot according to claim 1 wherein said controller halts the

movement on the road surface responsive to the amount of the relative movement

between the foot part and the road surface exceeding a preset threshold value during

movement on the road surface, searches the state of the road surface and executes an

operation corresponding to searched results.

12. The legged mobile robot according to claim 1 wherein the controller transfers to

a safe movement operation pattern for the road surface responsive to the amount of the

relative movement between the foot part and the road surface exceeding a preset

threshold value during movement on the road surface.

13. The legged mobile robot according to claim 12 wherein the safe movement operation pattern is at least one of enlarging the incidence angle of the foot part touching the road surface, lowering the movement speed, diminishing the footstep of each movable leg and correcting the ZMP trajectory.

14. The legged mobile robot according to claim 1 wherein the controller transfers to the movement operations under searching the road surface responsive to the amount of the relative movement between the foot part and the road surface exceeding a preset threshold value during walking on the road surface.

15. The legged mobile robot according to claim 1 wherein the controller executes the processing of selecting a foot sole suited to the road surface responsive to the amount of the relative movement between the foot part and the road surface exceeding a preset threshold value during walking on the road surface.

16. A method for controlling a legged mobile robot having at least a plurality of movable legs, comprising:

a measurement step of measuring the amounts of relative movements between the foot part and the road surface when the respective movable legs touch the road surface; and

a controlling step of controlling the movements of the legged mobile robot based on the amounts of relative movements between the foot part and the road surface as measured.

17. The method for controlling the legged mobile robot according to claim 16 wherein the measurement step measures the amount of the relative movement of the foot part relative to a direction parallel to the road surface and/or the amount of the relative movement of the foot part around a normal of the road surface.

18. The method for controlling the legged mobile robot according to claim 16 further comprising:

a calculating step of calculating the amount of the relative movement around a normal of the road surface by chronologically joining the amounts of the relative movement in the direction parallel to the road surface of the foot part as measured in the measurement step at preset time intervals.

19. The method for controlling the legged mobile robot according to claim 16 wherein the measurement step includes a calculating step of measuring the amount of the relative movement between the foot part and the road surface at two or more spaced apart points and comparing the amounts of the relative movement measured at two or more points to one another to calculate the amount of the relative movement of the foot part around a normal of the road surface.

20. The method for controlling the legged mobile robot according to claim 16 wherein said controller halts the movement on the road surface responsive to the amount of the relative movement between the foot part and the road surface exceeding a preset threshold value during movement on the road surface.

21. The method for controlling the legged mobile robot according to claim 16 wherein

said controller halts the movement on the road surface responsive to the amount of the relative movement between the foot part and the road surface exceeding a preset threshold value during movement on the road surface and verifies whether or not the movement operation can further be continued.

22. The method for controlling the legged mobile robot according to claim 16 wherein said controller halts the movement on the road surface responsive to the amount of the relative movement between the foot part and the road surface exceeding a preset threshold value during movement on the road surface, verifies whether or not the movement operation can further be continued and executes a preset assistance request operation in case the controller verifies that the movement operations cannot be continued

23. The method for controlling the legged mobile robot according to claim 16 wherein said controller halts the movement on the road surface responsive to the amount of the relative movement between the foot part and the road surface exceeding a preset threshold value during movement on the road surface and searches the state of the road surface.

24. The method for controlling the legged mobile robot according to claim 16 wherein said controller halts the movement on the road surface responsive to the amount of the relative movement between the foot part and the road surface exceeding a preset threshold value during movement on the road surface, searches the state of the road surface and executes an operation corresponding to searched results.

25. The method for controlling the legged mobile robot according to claim 16 wherein the controller transfers to a safe movement operation pattern for the road surface responsive to the amount of the relative movement between the foot part and the road surface exceeding a preset threshold value during movement on the road surface.

26. The method for controlling the legged mobile robot according to claim 25 wherein the safe movement operation pattern is at least one of enlarging the incidence angle of the foot part touching the road surface, lowering the movement speed, diminishing the footstep of each movable leg and correcting the ZMP trajectory.

27. The method for controlling the legged mobile robot according to claim 16 wherein the controller transfers to the movement operations responsive to the amount of the relative movement between the foot part and the road surface exceeding a preset threshold value during walking on the road surface.

28. The method for controlling the legged mobile robot according to claim 16 wherein the controller executes the processing of selecting a foot sole suited to the road surface responsive to the amount of the relative movement between the foot part and the road surface exceeding a preset threshold value during walking on the road surface.

29. A relative movement measurement sensor for a legged mobile robot for measuring the amount of relative movement between a foot part and the road surface, the sensor being applicable to a foot part of a legged mobile robot having at least a plurality of movable legs comprising:

a rotationally mounted ball having its surface partially exposed to outside the

foot sole;

a first rotation unit for detecting the rotation in a first direction of the ball;

a second rotation unit for detecting the rotation in a second direction of the ball;

and

a calculation unit for calculating the amount of the relative movement of the

foot part relative to the road surface in the first and second directions.

30. A relative movement measurement sensor for a legged mobile robot for measuring

the amount of relative movement between a foot part and the road surface, the sensor

being applicable to a foot part of a legged mobile robot having at least a plurality of

movable legs comprising:

imaging means for imaging a ground touching surface of the foot part;

image processing means for comparing images photographed by the imaging means at a preset time interval; and

calculating means for calculating the amount of the relative movement relative to the road surface of the foot part at the preset time interval based on the results of image comparison by the image processing means.